

Verification of *Sargassum natans* (Linnaeus) Gaillon (Heterokontophyta: Phaeophyceae) from the Sargasso Sea off the coast of Brazil, western Atlantic Ocean

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ABSTRACT: The Sargasso Sea, named due to the floating presence of *Sargassum fluitans* and *S. natans*, is usually reported for the tropical region of the Northern Hemisphere. On 14 July 2011, at 02°45' N and 48°28' W, samples of pelagic seaweed masses were collected by the Patrol Ship Bracuí of the Brazilian Navy. The seaweed was identified as *S. natans*, previously considered as of doubtful occurrence in Brazil.

The Sargasso Sea is reported for the western Atlantic tropical region of the Northern Hemisphere; it is encircled by a gyre formed by the Gulf Stream, the North Equatorial Current and the North Atlantic Drift (Lüning 1990). The Sargasso Sea occurs as a pelagic ecosystem, growing on the surface of the sea in nutrient-poor oceanic regions. The distribution pattern of pelagic *Sargassum* C. Agardh (Fucales, Phaeophyceae, Heterokontophyta) is in small to massive clumps that tend to line up in rows in the direction of the winds. During periods of calm weather, the drifting seaweeds aggregate into larger patches (Butler *et al.* 1983). The two species of the genus *Sargassum* that dominate the floating algal communities of the Sargasso Sea are *S. fluitans* (Boergesen) Boergesen, and *S. natans* (Linnaeus) Gaillon. *Sargassum fluitans* and *S. natans* are taxonomically valid species (Guiry and Guiry 2011), and both occur in the western Atlantic Ocean (Wynne 2011). These species are similar in the following characteristics: their populations reproduce by vegetative fragmentation; sexual reproductive structures were solely described for Cuba by Moreira and Suárez (2002); they have no holdfast; their lateral branches are extensively ramified, long, and tangled; large numbers of air bladders are formed along the lateral branches; their blades (phylloids) are large, with serrate or dentate margins; and there are few or no cryptostomata on their surfaces (Taylor 1960; Schneider and Searles 1991; Littler and Littler 2000; Dawes and Mathieson 2008). Numerous air bladders allow the thalli to float.

Sargassum natans has a broad geographic distribution, being reported from Central America, North America, Australia, New Zealand, the southeast and southwest coasts of Asia, Africa and Europe, including islands of the Caribbean and the Atlantic Ocean (Guiry and Guiry 2011). As a pelagic species it has no defined range other than the North Atlantic (Schneider & Searles 1991). *Sargassum fluitans* has a more limited distribution: Central America, North America, southeast and southwest Asia, and also

including islands in the Caribbean and elsewhere in the Atlantic (Guiry and Guiry 2011).

Sargassum natans was first reported for the Brazilian coast in the floristic list published by Taylor (1931), based upon the listing of *Sargassum bacciferum* (Turner) C. Agardh for Brazil by Martens (1870). *Sargassum bacciferum* is presently a taxonomic synonym of *S. natans* (Guiry and Guiry 2011). Oliveira Filho (unpubl. data), in his review of the species of macroalgae for Brazil, includes *Sargassum natans* as a doubtful species, but observed that it occasionally appears floating off the northern-northeastern Brazilian coast.

Other species are mentioned as floating thalli off the coast of Brazil. Oliveira Filho *et al.* (1979) reported the occurrence of *Sargassum hystrix* J. Agardh and *S. platycarpum* Montagne floating in waters of the Brazil Current, about 100 km from the coast, at parallel 18°15'S. These species are common in drift on the shores of the northeastern and southeastern Brazilian coast (Széchy and de Paula 2010). The occurrence of pelagic specimens of *S. hystrix* was explained by the occurrence of benthic populations in deep bottoms of the area (Oliveira Filho *et al.* 1979). *Sargassum hystrix* is cited by Guimarães *et al.* (1981), as dredged material from 90 m depth, together with calcareous algae, during the Canopus Commission between the states of Ceará and Sergipe (05°55'00" S, 34°58'00" W).

The present study describes and illustrates the morphology of the brown alga *Sargassum natans* found offshore on the northern Brazilian coast as floating masses. Floating masses were first noticed by the Brazilian Air Force at the coordinates 04°12' N, 47°22' W, on 9 July 2011, when they were mistakenly identified as an oil spill (Figure 1). Subsequently, additional spills were seen at the following coordinates: 01°58' N, 48°30' W; 03°09' N, 49°17' W; 03°42' N, 48°18' W; 04°13' N, 47°17' W. On 14 July 2011, at coordinates 02°45' N, 48°28' W, samples were taken from the sea by the Patrol Ship *Bracuí* of the

Brazilian Navy, when seaweeds were recognized as the component of those spills (Figure 2). On that date, the patch extended over about five nautical miles, in the northeast to southwest direction.



FIGURE 1. Floating mass of *Sargassum* off northern Brazil- more distant aerial photograph.



FIGURE 2. Floating mass of *Sargassum* off northern Brazil- closer aerial photograph.

The collected seaweeds were kept at low temperatures, in a freezer, and were then transferred to a 4% formaldehyde solution. Three primary lateral branches were analyzed for the description of the external and internal morphology, including qualitative and quantitative characteristics. Ten blades and ten air bladders from each branch were measured. Cross sections were made using razor blades. Taxonomic identification was based on descriptions provided in studies carried out in the western North Atlantic Ocean. Vouchers were deposited in the Herbarium of the Department of Botany, Institute of Biology of the Federal University of Rio de Janeiro (RFA).

Primary lateral branches, measuring (25.0-)33.0(-47.0) cm in length, are much branched, with first- and higher-order branches densely arranged and tangled (Figure 3). Spines are present along the primary lateral branches, mainly in their upper portions (Figure 4); these spines are abruptly tapered and measure (320-)450(-680) μm in length. In cross section, primary lateral branches have a cylindrical outline and measure approximately 1 mm in diameter in median portions. Blades are spirally attached to the axes of branches by a short pedicel. The blades are firm, simple, narrow and lanceolate with predominantly symmetrical bases and acute apices (Figure 5), measuring

(1.9-)2.3(-2.8) cm in length and (2.5-)2.8(-4.0) mm in width [length/width ratio: (4.7-)6.2(-8.6)] and (110-)148(-180) μm in thickness at the middle part of the blade. Midribs are evident in surface view but not prominent in cross section, with a thickness of (230.0-)324.6(-400.0) μm . Margins of the blades are coarsely toothed (Figure 5) with aculeate teeth, measuring (300.0-)450.0(-750.0) μm in length. Cryptostomata are absent on the blades (Figure 6). Air bladders are very numerous along the axes and are present on branches of all orders, attached by pedicels, singly or in pairs (Figure 7), predominantly oval or spherical (Figure 4), measuring (1.7-)2.2(-3.0) mm in diameter. Some air bladders terminate in a small spine or laminar projection. The pedicels of air bladders are cylindrical, and (1.2-)2.1(-3.8) mm in length. Receptacles are not present on the specimens (voucher RFA 35.700).

Based on these morphological characteristics, the offshore pelagic *Sargassum* analyzed was identified as *S. natans*. The Brazilian specimens are similar to the descriptions of *S. natans* from the North Atlantic Ocean in the width of the blades and also in the typically dentate margins of the blades. However, the material from Brazil showed less extended blades, being shorter than those described for the Caribbean and Florida. The Brazilian specimens differ from those described by Taylor (1960), Schneider and Searles (1991), Littler and Littler (2000) and Dawes and Mathieson (2008) with respect to the presence of spines on the axes of the primary lateral branches and their branches. Spines on the axes of the primary lateral branches are mentioned in the literature for *S. fluitans* (Table 1).



FIGURE 3. *Sargassum natans* from a floating mass off northern Brazil- primary lateral branch with its very dense first-order branches. Scale bar = 5 cm.

TABLE 1. Summary of the morphological characteristics used by different investigators, to separate *S. natans* from *S. fluitans*, both in the identification keys (underlined) and in the descriptions.

LATERAL BRANCHES		BLADES		AIR BLADDERS:	
		Form	dimensions	Margins	apical appendices
Taylor (1960)					
<i>S. fluitans</i>	smooth or very sparingly spinulose	<u>lanceolate</u> , with asymmetric base and obtuse to acute tips	2-6 cm x 3-8 mm	<u>with broad teeth</u>	<u>at most muticous</u> , not apiculate
<i>S. natans</i>	smooth	<u>linear</u>	2.5-7.0(-10) cm x 2.0-3.5 mm	slender, <u>aculeate teeth</u>	sometimes smooth, <u>aculeate or with a long projection</u>
Schneider and Searles (1991)					
<i>S. fluitans</i>	smooth or sparingly spinulose	narrow to <u>lanceolate</u>	2-6 cm x 3-8 mm	<u>broad teeth</u>	<u>not apiculate and without terminal leaf</u>
<i>S. natans</i>	smooth	acutely <u>linear</u>	2-5(-10) cm x 2-4 mm	slender, <u>aculeate teeth</u>	<u>apiculate or with terminal leaf</u>
Littler and Littler (2000)					
<i>S. fluitans</i>	smooth or with few spines	narrow, asymmetric base and pointed apices	2-6 cm x 3-8 mm	toothed	<u>without a spine, hook or leaf-like projection with small spine, hooked spur or leaf-like projection</u>
<i>S. natans</i>	smooth	elongate, narrow	2-10 cm x 1-4 mm	coarsely toothed	<u>hooked spur or leaf-like projection</u>
Dawes and Mathieson (2008)					
<i>S. fluitans</i>	smooth to slightly spiny	<u>lanceolate</u> with pointed tips	2-6 cm x 3-8 mm	<u>broad teeth</u>	<u>usually without a spine</u>
<i>S. natans</i>	smooth	<u>linear</u>	2-10 cm x 1-4 mm	<u>slender teeth</u>	<u>often with a spine, hook or minute blade</u>
Present study: Brazilian plants	with spines	narrow, lanceolate	1.9-2.8 cm x 2.5-4 mm	with aculeate teeth	sometimes with a spine or laminar projection



FIGURE 4. *Sargassum natans* from a floating mass off northern Brazil- axis of a primary lateral branch with air bladders. Note the spines. Scale bar = 10 mm.



FIGURE 5. *Sargassum natans* from a floating mass off northern Brazil- apical portion of a branch. Note lanceolate blades with aculeate teeth. Scale bar = 1 cm.

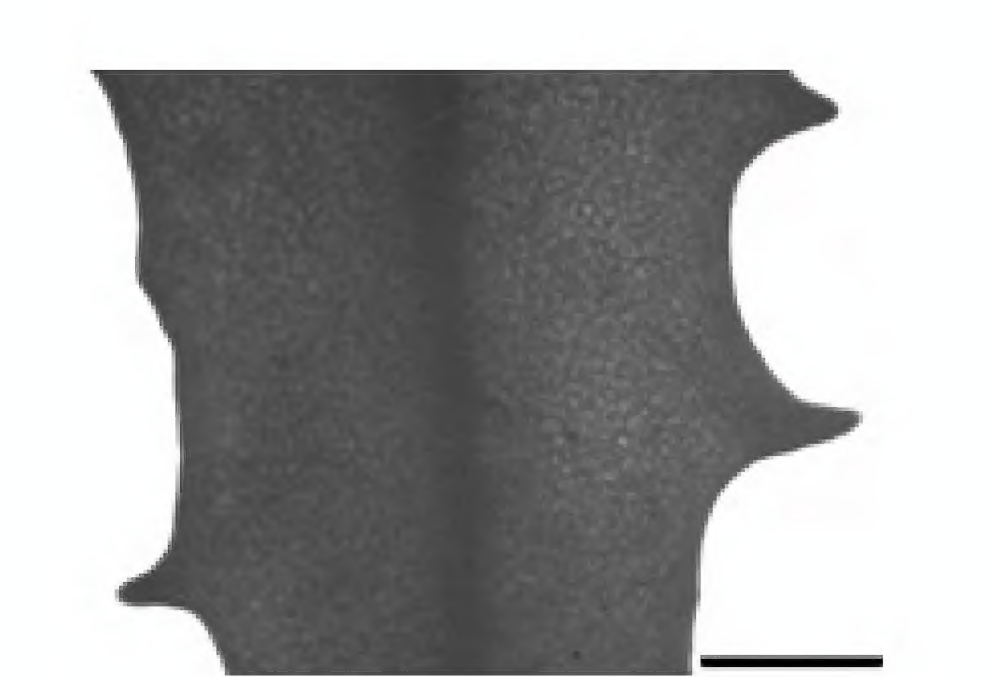


FIGURE 6. *Sargassum natans* from a floating mass off northern Brazil - blade in surface view, showing no cryptostomata. Scale bar = 1.5 mm.

This study is in agreement with previous reports (Taylor 1931) that mentioned the occurrence of *Sargassum natans* for Brazil, information that was later questioned by other investigators. Taylor (1960) himself later noted that the report of this species from Brazil was outside the natural geographical range of the species, and was followed by Oliveira Filho (unpubl. data), who likewise considered the occurrence of *S. natans* in Brazil as doubtful. There is no concrete information about the origin of the huge *Sargassum natans* masses within the territorial waters of Brazil, yet it seems likely that they branched off the pelagic community well known and studied to the north in the Sargasso Sea.



FIGURE 7. *Sargassum natans* from a floating mass off northern Brazil – air bladders attached by pedicels, in pairs. Scale bar = 1 cm.

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